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RESEARCH REPORT

THE ROLE OF INTER-ORGANIZATIONAL COLLABORATION WITHIN INNOVATION STRATEGIES: TOWARDS A PORTFOLIO APPROACH

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The role of Inter-Organizational Collaboration within Innovation Strategies: Towards a Portfolio Approach

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Abstract

Within the innovation literature, inter-organizational collaboration is being advanced as instrumental for improving the innovative performance of firms. In addition inter-organizational collaboration can be instrumental for addressing the multiple requirements innovation strategies entail. At the same time - large scale - empirical evidence for such a relation is scarce. Within this paper we examine whether evidence can be found for the idea that inter-organizational collaboration supports the effectiveness of innovation strategies. Multivariate and Tobit analyses of data on Belgian manufacturing firms, collected by means of the CIS survey (n=221), reveals a positive relationship between inter-organizational collaboration and innovative performance. Moreover the findings reported here suggest the relevancy of adopting a portfolio approach towards inter-organizational collaboration.

Introduction: Organizing for Innovation.

Innovation, and more in particular technological innovation, has long been acknowledged as crucial for the long term survival and growth of the firm; at the same time technological innovation is one of the critical driving forces to elevate social welfare, besides its direct impact on economic performance (Baumol, 2002; Schumpeter, 1939; Tushman et al., 1997). However, managing innovation is not a straightforward exercise (Tushman et al., 1997; Van de Ven, et al. 1986, 1999). The complexities that arise when designing and implementing an innovation strategy are directly related to the multitude of objectives such a strategy should encompass. In this respect relevant insights have been advanced and discussed by, amongst others: Arrow (1962), Abernathy (1978), Dosi (1982), Abernathy and Clark (1985), Tushman et al. (1986), Anderson and Tushman (1991), March (1991), Ghemawat (1991), Utterback (1994), Argyres (1996), Bower and Christensen (1996), Solow (1997), Brown and Eisenhardt (1997), Van de Ven et al. (1999), Garud and Karnoe (2002), McDermott and O'Connor (2002). The notions of incremental versus radical innovation, innovation as continuous improvement via learning by doing versus innovation as creative destruction, flexibility to keep innovation options open versus commitment to well-defined innovation pathways, divergent versus convergent behavior, exploitation versus exploration or path creation versus path dependence, are at the core of the dualities being outlined. Whereas exploitation refers to activities such as improvement, refinement, efficiency, selection and implementation, exploration is best captured by notions like search, variation, experimentation and discovery (March, 1991.,p.102). Hence, organizations trying to achieve this broad spectrum of innovation activities are faced with multiple, often contradictory, demands confronting them with the challenge of reconciling paradoxical requirements (Benner & Tushman; 2003; Dougherty, 1996; Leonard-Barton, 1992; Roussel et al., 1991; Wheelwright & Clark, 1992).

Recently, several scholars have advanced the notions of semi- or quasi-autonomous structures (Brown and Eisenhardt, 1997; Schoonhoven and Jellinek, 1990) and ambidextrous organizations (Benner and Tushman, 2003; Tushman et al., 1997) to handle the paradoxical requirements encountered. Within those

configurations, conflicting ingredients can co-exist by adopting organizational designs that allow for differentiating explorative activities from their mainstream exploitation-oriented counterparts; an issue explicitly addressed by authors like Cooper and Kleinschmidt (1995), Cooper and Edgett (1999), and Christensen and Overdorf (2000). As a consequence, innovation strategies entail the deployment of organizational arrangements of a heterogeneous nature, whereby balancing the innovation efforts between different units over time becomes a crucial point of managerial attention (Van Looy, Debackere, Bouwen, 2003).

Within the work of several of the authors mentioned, inter-organizational collaborative arrangements are advanced as highly relevant for dealing with the aforementioned tensions. For instance, Brown and Eisenhardt (1997) pointed to the relevance of strategic alliances for probing into the future and hence to overcome the tensions related to combining short term, often improvement-oriented, and long term, often breakthrough-oriented, developments. Christensen and Overdorf (2000) advocate the idea of complementing 'traditional' organizational practices, with creating new organizational structures, spinouts and acquisitions to achieve the exploration oriented objectives of an innovation strategy.

With this contribution, we want to examine whether further empirical evidence can be found for the supportive role of inter-organizational collaboration in dealing with the innovation paradoxes discussed in the previous paragraphs. Stated otherwise, are firms that deploy a multitude – or portfolio – of inter-organizational collaborations within the framework of their innovation strategy, better able to achieve a mix of innovations of both a more incremental and radical nature? This empirical analysis will be done by analyzing data on Belgian firms collected with the CIS[1] survey. However, before describing the sample and the methods involved in more detail, we first discuss the existing and extant empirical findings on the role and impact of inter-organizational collaboration on innovation performance, as this will allow us to define our research questions more precisely.

The role of inter-organizational collaboration when innovating: towards specific propositions.

Inter-organizational collaboration has been recognized as important to supplement the internal innovative activities of organizations (Dodgson, 1993; Hagedoorn, 2002; Rothaermel, 2003). From the present literature, it becomes clear that organizations can improve their innovative capabilities by developing inter-organizational collaborations with a variety of partners. Collaborations with existing suppliers and customers (Shaw, 1994; Von Hippel, 1988), potential lead users (Quinn, 1985; Von Hippel et al., 1999), universities and research centres (Gerwin et al., 1992; Santoro, 2000; Tidd et al., 2002) and even potential or existing industry competitors (Dodgson, 1993; Hamel, 1991) have all been advanced as relevant in this respect.

The reasons why inter-organizational collaboration can contribute to the effectiveness and efficiency of an innovation strategy are numerous. First of all, inter-organizational collaboration can imply access to complementary assets needed to make innovation projects commercially successful (Hagedoorn, 1993; Teece, 1986). Second, working together with other organizations might bring along the transfer of codified and tacit knowledge (Ahuja, 2000; Doz & Hamel, 1997; Eisenhardt & Schoonhoven, 1996; Lambe & Spekman, 1997). Organizations can become familiar with new competencies that are emerging within or outside the industry in a stepwise way (Roberts & Berry, 1985). Such phased acquisition processes might result over time in the creation and development of resources that are otherwise difficult to mobilize, imitate and substitute (Das & Teng, 2000). Finally, inter-organizational collaboration also allows spreading the costs of R&D over different parties (Hagedoorn, 2002; Veugelers, 1998), reducing the risks that are associated with R&D intensive innovation projects significantly.

The fact that inter-organizational collaboration has considerable potential to contribute to the innovation strategies of organizations does not mean that all collaborations are successful though; on the contrary, estimates suggest that as many as 60 per cent of all alliances fail (Bleeke & Ernst, 1993; Harrigan, 1988). The occurrence of unintended knowledge spillovers (; Teece, 2002; Veugelers, 1998), the

manifestation of learning races between the partners (Hamel, 1991; Larsson et al., 1998), misinterpretations of intended benefits (Larson, 1992; Lorange & Roos, 1992), and lack of flexibility and adaptability (Doz, 1996; Ring & Van de Ven, 1994) are frequently cited reasons for alliance failure.

Despite the occurrence of such drawbacks, empirical results seem to confirm that, by forming strategic alliances, organizations can potentially access social, technical, and commercial competitive resources that otherwise would require years of operating experience (Ahuja, 2000; Eisenhardt & Schoonhoven, 1996; Gulati, 1998; Nohria & Garcia-Pont, 1991; Teece, 1986). Moreover, if managed successfully, such alliances seem to contribute to the innovation effectiveness of the firms involved. Tether (2002), for example, observed that organizations which introduced at least one innovation that was new to the market cooperated significantly more with suppliers, customers and competitors than organizations which had not introduced such an innovation. Similarly, Shan et al. (1994) found out that the number of agreements with commercial firms has a positive significant influence on the amount of patents issued by biopharmaceutical start-ups. In addition, Baum et al. (2000), by studying the stqrt-ups' performance in Canadian biotechnology, demonstrate that alliance network composition has a positive effect on biotechnology startups performance. Their analysis, from the perspective of the startup firm rather than the established firm, empirically validates the impact of inter-organizational arrangements on the performance of innovation. Nevertheless, they also acknowledged that there are limitations to the usefulness of collaborative agreements. In specific, the larger the number of a firm's collaborative agreements, the higher the risk of redundancy (i.e. the risk that different partners provide access to the same information or complementary knowledge; Burt, 1992; Gomes-Casseres, 1994). Therefore, Baum et al. (2000), came to the conclusion that it is not the amount of collaborative agreements per se, but rather the diversity of the firm's alliance network that is influencing the innovative performance of the firm.

From such findings, we tend to conclude that organizations that engage in a diverse network of inter-organizational collaboration are better equipped to create new or improved products and processes. Hence we hypothesize that:

H1: Firms that engage in a variety of cooperative arrangements – within the framework of innovation - will be more effective in terms of creating new and/or improved products.

Towards a more fine-grained approach

Several studies, examining the reasons why organizations engage in inter-organizational collaboration, have stressed the idea that different kinds of collaboration can serve different strategic and innovation objectives. Hagedoorn (1993), for example, illustrates that organizations will use technological oriented collaborations such as joint ventures, research corporations and joint R&D agreements to support long-term positioning strategies. Technology exchange agreements with for example customers or suppliers, on the other hand, can be seen as more short term oriented, cost-economizing agreements which are associated with control of either transaction costs or operating costs of organizations (Hagedoorn, 1993). Cairnarca et al. (1992) point into a similar direction by arguing that the reasons for and hence the role of inter-organizational collaboration will differ depending on the different technological life-cycle stages of an industry. Before technological maturity is achieved, organizations deploy technology watching activities in order to get rapid access to specialized know-how. Scanning activities resulting in joint R&D agreements, including initiatives for developing standards, are frequently observed during such episodes. In this way, organizations are able to deal with the flux and rapid change that characterizes such 'pre dominant design' episodes (Tushman & Anderson, 1986; Utterback & Abernathy, 1975). On the other hand, when technological maturity is setting in, process and supply-chain innovations become dominant. In these circumstances, organizations will tend to favor commercial and manufacturing agreements with customers and suppliers mainly to optimize existing technology, to exploit the existing technology in peripheral markets or to improve the commercial and manufacturing possibilities of the involved technology (Cairnarca et al., 1992).

More recently, researchers also started to make a distinction between different kinds of inter-organizational collaboration by looking at the learning objectives of these collaborations. Following March's (1991) dichotomy of exploration and exploitation, a distinction has been made between explorative and exploitative collaborations (Koza & Lewin, 1998; Rothaermel, 2001; Rowley et al., 2000). Using this distinction Rothaermel (2001) came to the conclusion that industry incumbents that focus on a network of exploitative relationships outperform industry incumbents that have a more explorative oriented network.

Within exploitative collaborations, the main purpose relates to enhancing existing organizational competencies. More specifically, exploitative collaboration will focus on leveraging existing skills (Koza & Lewin, 1998). This means that exploitative collaborations focus on tangible complementarities among the allied partners as they exchange explicit knowledge (Teece, 1992). To achieve these objectives, such cooperation will benefit from clear performance objectives that are translated into measurable output controls which will be monitored by formalized coordinating and control mechanisms (Koza & Lewin, 1998; Van De Ven & Walker, 1984). These collaborative agreements will be characterized by clear job responsibilities, centralized procedures and highly engineered work processes. We can expect that such a 'mechanistic' structuring of the collaboration can bring along significant improvements of efficiency, time-to-market and cost-characteristics when further developing existing technologies and products (Burns & Stalker, 1961; Tushman et al., 1997). Because these outcomes are the main objectives of incremental oriented innovation projects we hypothesize that:

> H2: The larger the number of exploitative collaborations, the more effective firms will be in further developing existing technologies and their implied products.

Explorative collaboration, on the other hand, is seen as instrumental to create new organizational competencies. In these collaborations explorative learning processes and joint experimenting will be the main issue (Koza & Lewin, 1998). Hence, a differential emphasis towards the exchange of intangible or tacit knowledge

can be observed. To achieve such learning objectives, alliance partners will rely more on personal and informal modes of coordination and control (Koza & Lewin, 1998; Van De Ven & Walker, 1984, Ring & Van De Ven, 1994). Such 'organic' structures, in which job responsibilities are less explicit and more flexible working procedures are established at the beginning, seem to suit innovation projects that focus on newness rather than efficiency (Burgelman, 1983; Burns & Stalker, 1961; Christensen & Overdorf, 2000; Tushman et al. 1997, Wheelwright & Clark, 1992). Therefore we hypothesize that:

> H3: The larger the number of explorative collaborations, the more effective firms will be in terms of developing new technologies and/or products.

Methodology

Data

The data used for this study are drawn from the second version of the Community Innovation Survey (CIS II) conducted in several member states of the European Union in 1997[2]. The survey intended to develop insights into the innovative behavior of private organizations[3]. In this study, the analysis is restricted to innovative firms within the Belgian manufacturing industry. These firms are distinguished from non-innovative firms, based on their answers to the questions about whether they innovated between 1994 and 1996[4]. Innovation is defined by introducing new or improved products, or, new or improved processes. In total, the sample used consisted of 221 actively innovating firms[5].

Description of variables

Indicators of the effectiveness of innovation strategies

In several studies that examine the link between inter-organizational collaboration and innovative performance, patent intensity has been used as a measure of innovative outcome (e.g. Ahuja, 2000; Baum et al., 2000; Shan et al., 1994).

However, the use of patent activity as a measure of innovativeness brings along some specific concerns. First of all, it has been argued that patents are primarily indications of inventive activity, which can not be equaled with innovation. Second, it can be observed that such an indicator is only useful within industries in which patents are an important outcome of inventive projects. Therefore, it is not surprising that studies using this indicator limit themselves to so-called technology intensive industries[6]. Third, the patent intensity gives only an indication of the successfulness of one type of inventive activity, namely innovative efforts that bring along an output that can be codified into an appropriable asset. However, a lot of inventions will not be appropriable to that extent (Teece, 2002). Given these concerns, it is possible that organizations that have limited or even no patents at all, at the same time create new or improved products or processes.

Given these concerns, we have chosen to use the composition of turnover as a measure of the effectiveness of innovation strategies; given the dataset used, the turnover realized in 1996 is being analyzed as a dependent variable. This turnover can be the result of 1) technological *new* products brought onto the market between 1994 and 1996, 2) technological *improved* products brought onto the market between 1994 and 1996 and 3) unchanged or marginal changed products between 1994 and 1996[7]. The proportion of the turnover attributed to new products is treated within this study as an indication of the effectiveness of the innovation strategy in terms of creating new technologies and related products. Likewise, the percentage of the turnover attributed to improved products is seen as an indicator of the effectiveness of the innovation strategy in terms of further developing existing technologies and products[8].

Indicators of inter-organizational collaboration

Within the CIS II survey, organizations indicate whether or not they engage in inter-organizational agreements within the context of innovation. Respondents had to answer whether or not they collaborated with 1) other organizations within the same group, 2) competitors, 3) customers, 4) consultants, 5) suppliers, 6) universities and 7) research institutes. For each of these different types of partners, further refinements relate to the location of the partner by using the following distinctions: Belgium, EU,

USA, Japan and other countries. In this way, 35 binary variables become available each representing a combination of one specific type of partner with one specific geographic location. In order to test the relationship between variety of collaborations and innovative outcome, we constructed a variable, reflecting the presence of collaboration with the different types of partners available. This variable, labeled 'σ-collaborations', ranges only from 0 to 7 as numerous partnerships with similar types of partners (e.g. three projects with customers or research institutes) are only counted once.

To analyze the relationships advanced within hypotheses 2 and 3, additional indicators, reflecting the difference between collaborations of an exploitative and explorative nature, are needed. Based on previous research, collaborations with customers and suppliers are assumed to be more exploitative oriented as such development efforts remain predominantly situated within a given value chain (Tripsas, 1997). Collaboration with these partners has been described as instrumental for optimizing continuously existing core competencies (Brown & Eisenhardt, 1995, 1997; Schoonhoven & Jelinek, 1997). Where collaboration with suppliers can improve significantly the operational efficiency of existing production processes (Dittrich, 2001), collaboration with customers puts needs of existing market segments high on the innovation agenda (Shaw, 1994; Von Hippel, 1988). In line, Christensen and Overdorf (2000) have convincingly argued that collaborations with partners and customers will not be helpful to support innovation projects of a more novel nature. These authors emphasize that collaboration with customers and suppliers will reinforce existing resources, procedures and values, while the creation of innovations of a more novel, path creating nature more often than not imply processes of 'creative destruction' (Schumpeter, 1939, 1959).

Therefore, by adding all the binary variables representing combinations that include collaborations with customers or suppliers, we created the variable '#Exploitation oriented collaborations' that has a range between 0 and 10 and that represents the extent to which an organization makes use of exploitative oriented collaborations.

Collaborations with universities and research institutes, on the other hand, might be seen as more explorative oriented. These kinds of collaboration will be focused on the creation of know-how and know-why of new materials and technologies that eventually can be translated into commercial development (Wheelwright & Clark, 1992). The main focus will be on the generation of new knowledge instead of the exploitation of existing knowledge. Again, by adding all the binary variables, representing combinations that include collaborations with universities or research institutes, the variable '#Exploration oriented collaborations' was created that has a score range between 0 and 10, indicating the extent to which an organization makes use of explorative oriented collaborations[9].

Control variables

Besides the intensity and nature of inter-organizational collaboration one might expect that variables like the size of the organization, the R&D intensity of the organization, the industry in which the organization is located, and whether or not the organization is part of a multinational/divisional entity will impact the nature and the outcomes of the organization's innovation strategy.

Differences between small, entrepreneurial business entrants and large, mature industry incumbents with regard to their innovative capabilities have been documented (e.g. Ahuja & Lampert, 2001; Christensen & Overdorf, 2000; Quinn, 1985). Therefore, the variable size measured by the natural logarithm of the number of employees, is included within the different models as a control variable. Likewise, it seems reasonable to expect that the internal innovation efforts of the organization will have an impact on the effectiveness of the innovation strategy of the organization. Therefore we included the variable 'R&D Intensity', that represents the ratio of the number of R&D employees divided by total number of employees, in the analysis. In addition, whether or not one belongs to a larger, multinational, entity (0/1) has been used as control variable, labeled 'Foreign Subsidiary'. Finally, we included the variable ''Industry' to control for industry effects in the different analyses. Following the industry dynamics outlined by Utterback & Abernathy (1975) one can expect that, within mature industries in which a dominant design is established the focus will be

on incremental innovation projects, while within emerging industries radical innovation projects will be the main focus. Table 1 provides an overview of the nine industries distinguished.

[TABLE 1 HERE]

Results

Descriptive Statistics.

In Table 2 an overview of the descriptive statistics can be found. The means for the variables Turn Over New Products and Turn Over Improved Products are 0.09 and 0.13. Taken into account that we used logarithmic transformations for these variables this implies that, on average, the respondents attributed 9 % of their turnover to technological new products and 15 % to technological improved products. From table 2 it becomes apparent that the variety of inter-organizational partners reported was rather limited. On average, the innovating firms used less than 2 out of the 7 collaborative partners that were indicated in the survey. Moreover, with regard to exploitative and explorative kinds of collaboration, innovating firms engage – on average - in less than 1 out of the 10 combinations proposed.

[TABLE 2 HERE]

As table 2 includes as well the correlations, one can notice that the amount of turnover attributed to technological new products is not only positively correlated with R&D intensity, but also with the different collaboration variables included in our analysis. Several positive correlations between the amount of turnover attributed to technological improved products and both the variety of collaborative agreements and the nature of exploitative oriented collaborative agreements can be noticed. This provides already a first indication that the collaborative behavior of organizations might be related to innovative performance.

The relationship between inter-organizational collaboration and innovative effectiveness

Within the first hypothesis the effectiveness of innovation strategies has been related to the presence of a multitude of inter-organizational co-operative arrangements. A straightforward analysis in this respect consists of relating the variety of collaborative agreements (σ-Collaborations) with the proportion of turnover generated by improved and new products while, at the same time, controlling for variables like size, industry, R&D intensity and whether one is a foreign subsidiary or not. In order to examine this relationship, a Tobit regression has been conducted (McDonald and Muffit, 1980, Greene, 2000) as this allows accounting for the presence of censored values[10].

Table 3 summarizes the findings of the Tobit analysis whereby the sum of the turnover resulting from new or improved products acts as the dependent variable. As becomes clear from table 3 the total number of collaborations is positively related to the effectiveness indicator used, supporting our first hypothesis. In addition, it can be observed that R&D intensity also has a positive impact on the extent to which an organization realizes turnover from new and improved products[11].

[TABLE 3 HERE]

The following two hypotheses include the introduction of a distinction between the effectiveness of innovation in terms of new versus improved products as well as a characterization of the nature of the inter-organizational collaborations (explorative versus exploitative).

Towards a more fine grained approach.

In our second hypothesis we stated that the use of exploitative collaborations will be beneficial with respect to the optimization of existing technologies and related products. The Tobit analysis[12], in which the collaboration variables (# Exploration

collaborations, # Exploitation collaborations) are related to the amount of turnover resulting from improved products, provides evidence in this respect. As table 4 makes clear the amount of exploitation oriented collaborations relates significantly to the presence and amount of turnover resulting from improved products ($p<0.0005$) while exploration oriented collaborations do not. The latter applies as well for size, R&D intensity and industry. Finally, whether or not one is part of a multinational organization does affect the presence of turnover derived from improved products, albeit in a negative way ($p<0.05$).

[TABLE 4 HERE]

We also hypothesized that the use of explorative collaborations would be beneficial for developing new products (H3). The results of the Tobit model in which the presence and the amount of turnover stemming from new products is used as a dependent variable, provides evidence for the hypothesis outlined, as Table 5 makes clear. Whereas the presence and amount of exploitation oriented collaborations does not relate significantly to the proportion of turnover generated by new products, this is clearly the case for exploration oriented collaborations ($p<0,01$). At the same time it can be noted that size is significantly negatively related to introducing new products, while R&D intensity is beneficial for introducing new products (although only significant at the 10 % level). As in the case of turnover of improved products, no industry differences have been observed.

[TABLE 5 HERE]

DISCUSSION

In this study we have tried to find some empirical evidence for the idea that the amount and variety of inter-organizational collaboration relates to the effectiveness of innovation strategies. The analyses conducted within this study confirm the hypotheses outlined. Firms that possess a heterogeneous network of collaborative partners within the framework of their innovation strategies perform better in terms of the proportion of turnover realized by means of new or improved

products. In addition, the difference between exploitative and explorative collaborations has been introduced to examine whether different kinds of collaboration relate to different types of innovation outcomes. More specifically, we hypothesized that exploitative oriented collaborations could support improving and further developing existing technologies and products, while explorative oriented collaborations would be beneficial for innovation objectives aimed at creating new technologies and products. Also these hypotheses have been to a large extent confirmed. On the one hand, collaborations with customers and suppliers, labeled as 'exploitative' are associated positively with higher levels of turnover stemming from improved products, while collaborations with universities and research organizations - labeled as explorative - are associated in a similar way with turnover levels related to new products.

Relevance for practitioners

Our findings suggest that companies, when conceptualizing their portfolio of innovation projects, should simultaneously consider the idea of a portfolio of inter-organizational arrangements in order to be effective in terms of developing improved and new technologies and products. Both explorative and exploitative innovation projects enhance the innovation performance of the firm, while at the same time their impact on improved and new development efforts differs. Hence, in order to execute a balanced portfolio successfully, the development and implementation of a portfolio of different though complementary inter-organizational arrangements should be envisaged. Inter-organizational arrangements that support and fuel explorative innovation activities, do differ from the ones that sustain and fuel exploitative innovation activity. As a consequence, practitioners should strive for a balance of explorative and exploitative innovation endeavors and explicitly monitor and model that balance. Moreover, practitioners will have to accept and to learn that they need to develop this diverse contact and collaboration network as both explorative and exploitative endeavors should be part of the same portfolio in order to achieve maximal effectiveness of their firm's innovation performance.

Issues for further research

Our models did only explain partially the variation present in the data. This amount of unexplained variance can be related to the absence of important variables which influence substantially how and to what extent organizations innovate. Burns & Stalker (1961), for example, proved already that the organizational structure will have a major influence on the innovative capabilities of an organization. More specifically, they observed that, while mechanistic organizations would excel in improving efficiency of existing core competencies (i.e. creating incremental innovations), organic organizations would be most suited to engage in the creative destruction of these same competencies (i.e. creating radical innovations). As became clear in the introduction, several scholars have stressed that the organizational structure will determine largely the innovative behavior of organizations (Schoonhoven & Jelinek, 1997; Brown & Eisenhardt, 1997; Tushman et al., 1997). However, because the CIS II survey did not provide data of the organizational structure of the respondents, we could not include this type of variables in the present analyses.

The fact that we used the data from a survey that was not designed for our specific research questions has also implications for the accuracy of the different indicators used. In the CIS survey, organizations are asked whether or not they use different collaboration possibilities without indicating the objectives pursued (developing existing technologies/products, or creating new ones). It is clear that the availability of such indications would be beneficial for analyzing the research hypothesis outlined within this contribution. Following recent contributions (e.g. Koza & Lewin, 1998, Rothaermel, 2001), we based our conceptual distinction between exploitative and explorative collaboration on the type of partner that was involved in the collaboration. More specifically, we assumed that collaborations with suppliers and customers will be more exploitative oriented, while collaborations with universities and research institutes will be more explorative oriented. However, a more reliable way to make a distinction between exploitative and explorative collaborations would be to assess explicitly the objectives of the different collaborations in which an organization engages. This would not only allow to assess if collaborations with suppliers and customers are indeed more exploitative oriented

and collaborations with universities and research institutes have a more explorative nature, it would also allow to integrate other kinds of collaboration, such as collaboration with competitors, into the exploitation/exploration dichotomy.

Conclusion

Despite these limitations, our findings revealed robust results in line with the hypotheses outlined. The purpose of this study was to assess whether the collaborative behavior of organizations relates to he innovative output of these organizations. Based on our results we can conclude that the more organizations use different collaboration possibilities, the more likely they are to create new or improved products that are commercially successful. Moreover, we also showed that different kinds of collaboration will be useful for different kinds of innovation outcomes. These results point out the relevance - for senior management – of adopting a portfolio approach towards inter-organizational collaborations in order to achieve results both in terms of developing existing technologies and creating new ones.

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Table 1 Overview of Sample Composition by industry.

	Frequency	Percent
Food, Beverages and Tobacco	14	6.3
Textile, Fur, Leather	12	5.4
Wood & Paper	11	5.0
Chemicals and Pharmaceuticals	59	26.7
Metals and Manufacturing	38	17.2
Machines	31	14.0
Electrical Equipment	36	16.3
Transport	15	6.8
Furniture	5	2.3
Total	221	100.0

Table 2: Descriptive statistics and correlations

Variable	Mean	S	Correlations					
			Turn Over New Products	Turn over Improved Products	Size	R&D Intensity	σ-Collaborations	# Exploitation oriented collaborations
Turn Over New Products	0.09	0.08	1					
Turn Over Improved Products	0.13	0.11	.18**	1				
Size	5.22	1.44	-.00	.03	1			
R&D Intensity	0.05	0.06	.16*	.11	-.01	1		
σ -Collaborations	1.69	1.95	.15*	.15**	.44**	.12	1	
#Exploitation oriented collaborations	0.89	1.43	.22**	.24**	.36**	.11	.76**	1
#Exploration oriented collaborations	0.74	1.34	.25**	.13	.48**	.24**	.69**	.59**

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 3: Tobit Analysis whereby the sum of turnover resulting from new and improved products acts as dependent variable.

Variable	Estimate	St Error	Chi-Square	Pr > ChiSq Label
Intercept	0.188	0.052	13.076	0.000
Foreign Subsidiary	-0.045	0.024	3.530	0.060
Size	-0.004	0.008	0.273	0.601
Textile, Fur, Leather	0.105	0.056	3.507	0.061
Wood & Paper	0.054	0.057	0.874	0.350
Chemicals and Pharmaceuticals	-0.008	0.042	0.035	0.852
Metals and Manufacturing	0.017	0.044	0.147	0.702
Machines	0.059	0.046	1.703	0.192
Electrical Equipment	0.050	0.045	1.242	0.265
Transport	0.075	0.053	1.951	0.163
Furniture	0.058	0.073	0.626	0.429
R&D Intensity	0.374	0.182	4.235	0.040
σ-Collaborations	0.018	0.006	10.382	0.001
Number of Obs.: 221				
Censored observations: 6				
Noncensored observations: 215				
LR chi^2: 34.88				
Prob > chi^2: < 0.005				
Pseudo R^2: 0.136				

Table 4: Results of Tobit Analysis – Dependent variable: Presence/Proportion of turnover resulting from improved products.

Variable	Estimate	St Error	Chi-Square	Pr > ChiSq Label
Intercept	0.099	0.047	4.464	0.035
Foreign Subsidiary	-0.041	0.020	4.127	0.042
Size	-0.000	0.007	0.000	0.994
Textile, Fur, Leather	0.062	0.048	1.668	0.197
Wood & Paper	-0.008	0.050	0.025	0.874
Chemicals and Pharmaceuticals	-0.014	0.036	0.138	0.710
Metals and Manufacturing	0.031	0.038	0.656	0.418
Machines	0.058	0.039	2.174	0.140
Electrical Equipment	0.044	0.039	1.273	0.259
Transport	0.029	0.046	0.392	0.531
Furniture	0.028	0.063	0.191	0.662
R&D Intensity	0.170	0.158	1.147	0.284
# Exploitation oriented collaborations	0.026	0.007	12.767	< 0.001
# Exploration oriented collaborations	-0.007	0.009	0.620	0.431
Number of Obs.: 221				
Censored observations: 179				
Noncensored observations: 42				
LR chi^2: 25.63				
Prob > chi^2: <0.025				
Pseudo R^2: 0.103				

Table 5: Results of Tobit Analysis – Dependent variable: Presence/Proportion of turnover resulting from new products.

Variable	Estimate	St Error	Chi-Square	Pr > ChiSq Label
Intercept	0.082	0.036	5.200	0.023
Foreign Subsidiary	0.004	0.016	0.073	0.788
Size	-0.012	0.006	4.340	0.037
Textile, Fur, Leather	0.058	0.038	2.391	0.122
Wood & Paper	0.060	0.038	2.478	0.116
Chemicals and Pharmaceuticals	0.016	0.028	0.313	0.576
Metals and Manufacturing	-0.000	0.030	0.000	0.989
Machines	0.011	0.031	0.136	0.713
Electrical Equipment	0.014	0.030	0.207	0.649
Transport	0.068	0.036	3.693	0.055
Furniture	0.046	0.048	0.904	0.342
R&D Intensity	0.208	0.005	2.678	0.085
# Exploitation oriented collaborations	0.009	0.005	2.679	0.102
# Exploration oriented collaborations	0.017	0.006	7.18	0.007
Number of Obs.: 221				
Censored observations: 43				
Noncensored observations: 178				
LR chi^2: 32.61				
Prob > chi^2: <0.005				
Pseudo R^2: 0.129				

FOOTNOTES

1. The CIS survey, or Community Innovation Survey, is a bi-yearly survey organised by Eurostat and the European Commission aimed at obtaining insight into the innovation performance of the various EU-member states. The results of the CIS-surveys are incorporated in the Innovation Scoreboards published by the Commission.
2. For more detailed information about the survey we refer to http://www.belspo.be. For the CIS II survey a representative sample of 2164 Belgian manufacturing firms was selected and an 11-page questionnaire sent out to them. The response rate was 64 % (1377)
3. The authors are grateful to DWTC for granting access to the data.
4. Only the innovating firms needed to fill out all questions in the survey. Restricting the sample to innovating firms might lead to sample selection cooperation is an important way to innovate for firms that would otherwise not be innovative. This assumption however is unlikely, given that all firms that cooperate do have some other innovation strategies, such as own R&D or some form of external knowledge acquisition.
5. The amount of missing values was particularly high on the question of 'total number of R&D personnel in 1996'. 62 of the innovating organizations did not report a specific amount on this question.
6. For some exceptions that have focused on multiple industries, see: Kleinknecht & Reijnen (1992); Fritsch & Lukas (2001) and Tether (2002)
7. A technologically improved product is an existing product whose performance has been significantly enhanced or upgraded. A simple product may be improved (in terms of better performance or lower cost) through use of higher-performance components or materials, or a complex product which consists of a number of integrated technical sub-systems may be improved by partial changes to one of the sub-systems (The measurement of scientific and technological activities, Oslo Manual - OECD/Eurostat, 1997, p. 49). A technologically new product is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. Such innovations can involve radically new technologies, can be based on combining existing technologies in new uses, or can be derived from the use of new knowledge. (The measurement of scientific and technological activities, Oslo Manual - OECD/Eurostat, 1997, p. 48)
8. In the analyses we do not use the proportion of turnover attributed to new/improved products itself but the natural logarithm of 1 + the proportion of turnover attributed to new/improved products in order to obtain a normal distribution.
9. For the other types of partners (within the group, competitors), no straightforward diagnosis in terms of exploration of exploitation seems plausible (e.g. working within the boundaries of the group, might imply pursuing synergies with other Business Units (improving existing products) as well as cooperation with corporate R&D which might include projects aimed at developing new products. Likewise collaboration with competitors might both bring along the creation of new products (e.g. standard development within emergent technologies/applications) as well as the optimization of existing products (e.g. bundling of products/services).
10. According to the decomposition logic of McDonald and Moffitt (1980), within the estimated model, 87% of the total change in innovation resulting from a change in the independent variables would be generated by marginal changes in the value of innovation, whereas 13% would be generated by changes in the probability of innovating anything at all.
11. For one industry (Textile, Fur, Leather) one notices a positive effect compared to our reference industry (Food, Beverages and Tobacco) although not significant at the 5% ($p<0,10$); a finding the authors attribute to the presence within this industry of a limited number of (internationally) strong companies who have develop this strong competitive position by innovating. In addition, it can be observed that being part of a multinational firm tends to result in lower levels of innovative activity ($p<0,10$).
12. Within these two Tobit models, 59% of the total change in innovation resulting from a change in the independent variables would be generated by marginal changes in the value of innovation, whereas 41% would be generated by changes in the probability of innovating anything at all.